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The Influence of Nutrition Labeling and Point-of-Purchase Information on Food Behaviours

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Abstract Point-of-purchase information on packaged food has been a highly debated topic. Various types of nutrition labels and point-of-purchase information have been studied to determine their ability to attract consumers' attention, be well understood and promote healthy food choices. Country-specific regulatory and monitoring frameworks have been implemented to ensure reliability and accuracy of such information. However, the impact of such information on consumers' behaviour remains contentious. This review summarizes recent evidence on the real-world effectiveness of nutrition labels and point-of-purchase information.

Keywords Point-of-purchase information · Nutrition labeling · Claims · Nutrition policy · Front-of-pack nutrition labels · Purchase behaviour · Consumer

Abbreviations

FOP	Front-of-pack
FSANZ	Food Standard Australia New Zealand
TL	Traffic-light
MTL	Multiple traffic-light
DIG	Daily intake guide
GDA	Guideline daily amount
NIP	Nutrition information panel

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Introduction

Point-of-purchase (POP) information on food items is a potentially efficient tool to promote healthy diets. With rising rates of obesity, POP information that enables consumers to assess healthiness of foods and to align consumption with dietary guidelines is of particular interest for health research and policy. Such information is usually provided in form of labelling, either on package, or externally (for example, shelf labelling).

Rayner et al. [1•] classify POP food labels in two categories: claims and information. Claims are statements highlighting a specific quality, nutrient or ingredient of a food item (nutrition and ingredient claims, warnings) or a particular health benefit (health claims), such as improved body function or lower disease risk [1•, 2]. Overall health logos, such as Heart Foundation Tick or Choices logo, are included in the claims category by Rayner et al. [1•], and the same classification will be followed in this review for consistency. However, it is worth noting that such logos are classified as summary nutrition labels by other authors [3].

Information labels include nutrition declaration, supplementary nutrition information and other information (such as ingredient lists) [1•]. Regulations and monitoring frameworks are necessary to ensure that food labels are reliable, truthful and useful for consumers [1•, 4, 5]. Most of the countries endorse nutrition labels on packaged foods, either on all products, or products carrying health claims [6]. Some claims, for example warning statements about certain allergens, may be required in addition to a standard nutrition label, depending on regulations of a particular country [7]. Country-specific regulations also exist for health and nutrient claims [2, 8, 9].

Use of food labels is associated with healthier diet [10]. Modelling studies estimate that adoption of effective labelling schemes would be cost-effective and translate into significant health benefits for the population [11, 12]. However, there is

ongoing debate on the effectiveness of labels in influencing consumer behaviour [13]. Several previous reviews discuss POP information use and effectiveness based on evidence published up to 2010 [3, 13, 14]. One systematic review explored influence of POP information on shopping behaviour using objective sales data [13]. Another systematic review focused on use and understanding of front-of-pack (FOP) and shelf nutrition labelling, and included both objective and self-reported data, and performed a comparison of different labelling formats [3]. A further review paper presents evidence on nutrition label use in Europe [14]. All three reviews report mixed and inconclusive results regarding the impact of POP information on consumers' food choices and purchasing behaviour. Limited evidence using objectively measured data in real world settings is a particular gap identified by those studies.

The aim of this review is to provide an overview of the findings of the most recent studies, published between 2011 and 2014, examining the effect of POP nutrition and health information on consumer choices and purchasing behaviour. We included self-reported and objectively measured data, from both experimental and real-life designs in retail settings. A brief overview of menu labelling is also provided, although more detailed reviews of the effect of POP information in cafeteria and fast food settings are available elsewhere [14, 15].

POP Menu Labelling

Many types of menu labelling interventions, including calorie labelling [16], interpretive labelling such as traffic-lights [17–19] and "go-for-green" [20], signposting labelling such as "healthy choices" [21], have been conducted to assess the impact of FOP nutrition information on customers' food choice. Detailed assessments of the study results have been provided in recent systematic reviews, and are therefore excluded from this paper [15, 16, 22]. In brief, although the studies report mixed results, recent systematic reviews concluded that overall quantitative, not interpretive, calorie labelling on restaurant menus had no significant effect on consumers purchasing behaviour [15, 16], whereas calorie labelling provided in an interpretive way resulted in reduction of calorie purchasing [15]. Consistently with other nutrition labelling studies, results of the menu labelling interventions differ by socio-demographic characteristics; for example, menu labels appear to have higher effect on women than men [15].

POP Claims

Previous reviews identified that consumers are interested in claims, however their understanding depends on the level of education, socioeconomic status [8, 9]. There is no conclusive evidence regarding the extent to which health claims are used and can influence consumers' food purchasing decisions; previous studies report mixed results [3]. One criticism of claims is the potential "halo" effect, i.e. when a claim-carrying food is perceived as generally healthy and inhibits consumers from referring to further nutrition information [8]. Reliability and regulation of claim information, and how it is subsequently understood by consumers, is another concern. Strictness of claim regulation differs across countries, and health claims are not always required to be based on solid scientific evidence [9]. One example is US "qualified claims" which may be based on emerging research findings [9]. Although the strength of scientific evidence must be disclosed in case of US claims (using grading system on a claim), it is questionable whether consumers' understand this message, or whether they could be misled by qualified claims, accepting them as a reliable source of information [9].

Studies on the impact of claims published between 2011 and 2014 that were included in this review are summarised in Table 1. Methodologies used in these studies included surveys and interviews [23–26, 36–38], focus groups [24], consumer panels [24], choice experiments in laboratory setting [36], sales data analyses [27], product data analyses [26] and nutrient composition database analyses [28].

Use and Perception

Demographic characteristics of consumers who report using claims are consistent with common trends of food label use, i.e. higher use among females, consumers with higher education level and those with health or weight concerns [23]. While some claims are trusted by consumers, for example a Heart Foundation Tick [23], others are regarded with scepticism. One study that explored consumers' attitudes to health claims in prebiotic-enriched breads within two focus groups found overall strong negative attitude to claims. Consumers questioned the validity of health claim information, especially when it was related to risks of serious conditions such as cancer [24]. The same study, however, showed participants had significantly higher intention to purchase products with health, disease risk reduction or nutrient content claims.

Impact on Food Choices

Studies that have explored the impact of claims on food purchasing decisions report that consumers' familiarity with a product and the format of the claim are among factors determining the impact [36, 37]. Two studies found that health claims influenced buying decisions of consumers who were less familiar with a particular product, whereas for regular consumers the presence of health claims did not make a difference [36, 37]. A US survey assessing effect of health claims on purchases of soy-based foods found that claims increased

Table 1 Studies on point-of-purchase claims and nutrition labels

Reference	Goal	Design	Result
Williams et al.[16], 2014; Australia	Assessing perception and self-reported use of Australian Heart Foundation Tick	Subjects: adult members of national phone interviewing panel (n=1446) Methods: web-based survey	High trust to the organisation (79 %), high label use (76 %). Use associated with presence of diet-related and/or medical conditions.
Coleman et al.[17], 2014	Consumers' attitudes towards health claims on prebiotic-enriched breads	Subjects: consumer focus group (n=12), nutrition focus group (n=8); survey participants (n=122) Methods: focus groups, purchase intentions survey, consumer panel (n=100)	Focus groups: overall negative attitude to health claims Survey: higher intention to buy for products with health claims Consumer panel: no differences in liking of products with or without health claims.
Aschemann-Witzel et al.[18]; 2013; Germany	Effect of health claims on organic food purchases	Subjects: adult consumers of organic food (n=210) Methods: survey, purchasing experiment in laboratory setting, interview	Overall no difference in purchases of organic products with or without claims. Higher purchases of claim-carrying products among irregular buyers of organic products. No difference for regular buyers.
Moon et al.[19]; 2011; USA	Effect of health claims on soy-based product purchases	Subjects: household, members of online consumer panel (n=3456) Methods: survey	Increase in willingness to buy soy-based products with health claims for non-consumers and irregular consumers, but no difference for regular consumers.
Wong et al.[20], 2013; Canada	Effect of various formats of sodium health and content claims consumers' attitudes, understanding and intention to buy	Subjects: adult member of Consumer Monitor Panel (n=506) Methods: survey	Consumers' higher rating of sodium nutrient content and disease risk reduction claim formats, compared to function or taste claims. Both nutrient content and disease risk reduction claims increased self-reported intention to buy claim carrying food products.
Andrews et al.[21], 2011; USA	Effect of Smart Choice logo, TL and GDA FOP labels on product healthiness perception	Subjects: adults member of online research panel (n=520) Methods: survey	FOP Smart Choices logo leads to a "halo" effect compared to products with no logo, making participants perceive such products as healthy. This effect is smaller for products with TL or GDA FOP labels.
Hughes et al.[22], 2013; Australia	Healthiness of products carrying health and nutrition content claims	Methods: observational survey of products in three large stores	31 % of products carrying health claims did not meet the nutrient profiling criteria. 29 % of products carrying nutrient content claim were rated as unhealthy.
Elbel et al.[23], 2013 l; USA	Effect of "less healthy" shelf labelling and taxation on purchases of unhealthy products	Methods: sales data analyses	Decreased purchases of unhealthy items in presence of labels (6 % decrease) or taxation (11 % decrease)
Rosentreter et al. [24], 2013; New Zealand	Comparison of New Zealand food healthiness assessed by FSANZ and Traffic-Light nutrient profiling methods	Methods: packaged food nutrient composition database analyses	38 % of New Zealand food is classified as healthy as per FSANZ criteria, and eligible to carry health claims. 61 % of these foods received at least one "red" traffic light as per Traffic-Light criteria.
Gregori et al. [25], 2014; Europe	Assessing consumers' perception and understanding of nutrition labels	Subjects: adults Methods: phone survey	High self-reported use of nutrition information (71.8 %). Higher preference for "per serving" presentation of information, but better ability to interpret "per 100 g" information among participants. Understanding of complex nutrition labels like GDA was associated with higher education levels.
Hienke et al. [26], 2012; Germany	Understanding of traffic-lights FOP labelling scheme	Country: Germany Subjects: undergraduate students (n=2002) Methods: online survey; choice experiment	High self-reported level of understanding, moderate usefulness rating. Resulted in a decreased of high-fat and high-sugar food choices.
Vemula et al. [27], 2013; India	Use and understanding of nutrition labels	Subjects: adolescents (10-19 years; n=600); adults (20-59 years; n=600); elderly (over 60 years; n=600) Methods: survey; focus groups	Over 90 % of subjects reported reading the label. Most commonly viewed information: brand (85 %); expiry/manufacturing date (80 %); list of ingredients (20 %). Among self-reported users of nutrition information (40 %) most commonly viewed were fat and calorie content.

Table 1 (continued)

Reference	Goal	Design	Result
Watson et al. [28], 2013; Australia	Understanding of "energy" component of nutrition labels among Australian consumers	Subjects: adult consumers (interview n=40, survey n=405) Methods: face-to-face interview, survey	Limited understanding on "high energy food" and "low energy food" concepts among participants.
Aschemann-Witzel et al.[29], 2013; Germany, Poland	Effect of different FOP nutrition labels on food choices among snack food	Subjects: adults (n=1000) Methods: choice experiment	Presence of nutrition labels affected healthiness of choice only when consumers were asked to make healthy choices. Presence and format of nutrition labels did not have an effect on the levels of motivation towards making healthy choices.
Rahkovski et al.[30], 2013; USA	Impact of Guiding Stars shelf labelling intervention on ready-to-eat cereal sales in Hannaford stores compared to control stores	Methods: sales data analyses	Implementation of Guiding Star labelling resulted in increased sales of ready-to-eat cereals with 1 (1.15 % increase), 2 (0.89 % increase) and 3 stars (0.54 % increase), and decreased sales of cereals not qualifying for star rating (2.58 % decrease), compared to control
Cawley et al.[31], 2014; USA	Impact of Guiding Stars shelf labelling intervention on total product sales	Methods: sales data analyses	Overall decline in total product sales after the Guiding Stars labelling implementation, due to reduced sales of unhealthy products.
Sacks et al., 2011[32]; Australia	Impact of MTL labelling on food purchases in online supermarket	Methods: sales data analyses	No effect on sales was shown
Van Camp et al. [33], 2012; UK	Adoption of FOP labelling schemes in UK across food categories	Methods: analyses of data from Global New Product Database, between Jan 2007 and Dec 2009	Use of FOP labels was associated with brand and food category. Within some food categories, use of TL FOP scheme was negatively associated with nutrient content (salt, sugar, fat and energy).
McLean et al.[34], 2014; New Zealand	Qualitative assessment of use and understanding of sodium labelling	Subjects: adult consumers (n=16) Methods: interview	Limited understanding and ability to interpret sodium information on nutrition labels.
Carter et al.[35], 2013; Australia	Audit of FOP DIG labelling on energy dense snacks	Methods: supermarket audit; product data analyses	Presence and type of DIG labels were associated with nutrient content of products. "Energy only" DIG was the most common type of DIG label.

willingness to buy among non-consumers and irregular consumers of soy product. However, claims did not increase willingness to buy among regular soy product consumers [37]. Similarly, a purchasing experiment in laboratory setting conducted in Germany assessed effect of health claims on organic food purchases and found that irregular buyers of organic food were more likely to purchase organic products if they carried food claims, whereas there was no difference for regular organic food buyers [36]. Another survey conducted in Canada compared three different formats of sodium claims (disease risk reduction, nutrient function, nutrient content) against a taste claims as a control, and found that sodium content and disease risk reduction claims on the front of package had greater influence on consumers intentions to buy a claim-carrying product, than nutrient function and taste claims [38]. Another US study found that using "less healthy" warning message, as oppose to "healthy" logos, had an impact on sales in an experimental shop setting, and reduced purchases of unhealthy items by 6 % [27].

Compliance with Regulations

There is an ongoing discussion around the potential "halo" bias associated with claims. One US study compared "healthiness" presumption for products qualifying for Smart Choice summary logo, which were high in sodium and cholesterol [25]. The study participants perceived such products as healthier when a claim (Choice logo) was present, compared to the TL and guideline daily amount (GDA) labels.

Given such potential bias, claim regulation becomes particularly important. A recent Australian study explored relationship between claims and product healthiness, assessed by Food Standard Australia New Zealand (FSANZ) nutrient profiling methods. The study assessed three product categories (non-alcoholic beverages, breakfast cereals and cereal bars) and found that 79 % of cereal bars, 17 % breakfast cereal and 17 % non-alcoholic beverage products carrying nutrient claims did not qualify as healthy according to FSANZ criteria [26]. In addition 31 % of products carrying health claims did not meet nutrient profiling criteria required by FSANZ Standard 1.2.7 [29]. Another study assessed the healthiness of health claim carrying products in New Zealand, i.e. those approved as "healthy" according to FSANZ criteria, using a nutrient profiling algorithm underlying traffic-light (TL) nutrition label [28]. The study showed that most of such products would still receive between 1 and 2 "red" traffic lights.

In summary, current results suggest that claims influence food purchasing decisions, however they are likely to have greater impact during the initial stage of getting familiar with a product or range of products, and have lesser impact for existing consumers. Format and source of claim are important and influence consumers trust. Compliance of claims with guidelines and regulations need to be monitored to ensure reliability of claim information.

POP Nutrition Information

There is mixed evidence around consumer use of POP nutrition information [3, 10]. Overall, previous reviews consistently report nutrition declaration information on the back-of-pack (BOP) to be less liked and harder to understand, especially among lower socio-economic groups, compared to interpretive front-of-pack (FOP) nutrition labels [10]. However, actual use of FOP labels and their impact on consumer choice remain unclear [3]. As for claims, nutrition label use is predominantly estimated using self-reported or survey data, or measured in experimental settings, with substantially less evidence available from real retail data [3, 30, 31].

Studies on nutrition information published between 2011 and 2014 that were included in this review are summarised in Table 2. Methodologies used in the studies included surveys and interviews [32–35], choice experiments [33, 49], sales data analyses [50••, 51, 52], focus groups [34] and product data analyses [53]. The studies explored consumers' perception [32, 33], use [34] and understanding [35, 54] of nutrition labels, as well as nutrition label prevalence [39•, 40, 53], compliance with guidelines [39•, 40, 41] and impact on food choices [33, 49, 50••, 52].

Use and Perception

Consumers appear to perceive nutrition labelling usefulness (both FOP and BOP) as limited. A phone interview study in Europe found high self-reported regular POP nutrition information use (over 70 %), but only a small percentage of participants (10.6 %) considered nutrition labelling to be potentially effective intervention to improve diet and reduce obesity [32]. Similarly in a survey on FOP multiple traffic-light (MTL) labelling participants' rating of the scheme as being an effective means to promote healthy diet was moderate [33]. In addition, use of POP nutrition information appears to be selective [34]. In a survey and focus group study, among participants who reported to use labels of packaged foods, the majority were looking for brand information (85 %) and expiration date (80 %). Among those consumers who did report using nutrition information (40 %), use was mostly limited to fat or calorie content. Other components of nutrition labelling are often poorly understood, as, for example, shown by a New Zealand survey exploring use of nutrition labelling to understand sodium content [54]. The study revealed poor understanding of salt and sodium content information, and low self-reported use.

Table 2 Studies comparing different point-of-purchase labelling formats

Bialkova et al. [39•], 2014	Influence of choice logo and GDA labels on consumer attention and choices	Subjects: university students (experiment 1: n=80; experiment 2: n=80) Methods: computer choice experiment, eye tracking	Colour-coded GDA had the highest attention and choice, followed by monochrome GDA. When adjusted for attention, choice was higher for choice logo-carrying products.
Van Herpen et al. [40], 2014; Germany, Netherlands	Effect of various FOP labels on healthiness of food choices	Subjects: Study 1: students and University staff (n=533); Study 2: students (n=87) Methods: Study 1: online survey; Study 2: computer choice experiment; eye tracking	All label types were effective in communicating health messages in certain experimental conditions. Only MTL was effective in all conditions.
Maubach et al. [41], 2014; New Zealand	Effect of FOP labels on consumer food choice	Subjects: adults (n=768)	Effect on choice: MTL and HSR increased frequency of healthy food choices compared to control (NIP); DIG increased frequency of healthy food choices less than MTL and HSR.
		Methods: online survey choice experiment	Effect on healthiness assessment: MTL was the most effective in enabling participants to determine between healthy and unhealthy food.
Babio et al. [42], 2013; Spain	Effect of simple vs colour-coded GDA on food choices in adolescent	Subjects: adolescents, 16-18 years of age (n=81) Methods: survey, choice experiment	Healthier choices (less energy, fat, sugar and salt) in colour-coded GDA group, compared to simple GDA
McLean et al. [43], 2012; New Zealand	Impact of interpretive FOP nutrition labels and claims on participants' understanding of sodium content in food	Subjects: adult members of online research panel with hypertension (n=600) and without hypertension (n=300) Methods: Online survey and choice experiment	Participants exposed to TL label had greater ability to distinguish between low and high sodium products, compared to participants exposed to control or percentage daily intake labels. Simultaneous presence of FOP label and claims increases ability to identify healthier choice.
Mejan et al. [44], 2013; France	Perception of FOP label format between different socio-economic groups	Subjects: adults (n=38763) Methods: Online survey	Higher preference for simple formats among lower levels of income and education
Roberto et al. [45], 2012; USA	Effectiveness of TL and Choices logo FOP labels in helping participants to identify healthier choices and understand nutrient composition of the products	Subjects: adult members of online research panel (n=480) Methods: online survey	Choice logo and MTL helped participants to identify correct choices in "healthy choice" quiz. MTL have greater impact, compared to control and Choices logo, on participants' ability to understand product's nutrient content in "fat, sugar and sodium" quiz.
Watson et al. [46, 2014]; Australia	Effectiveness of FOP labelling schemes in promoting healthy choices	Subjects: adult online consumer panel (n=4357) Methods: survey	MTL + overall rating (e.g. green), MTL + interpretive text, monochrome and colour-coded DIG arms were the most effective in helping participants to identify healthy choices in the questionnaire. Energy only DIG and Star Rating schemes were the least effective. MTL + overall rating FOP format had the shortest decision making time.
Koenigstorfer et al. [47], 2013	Effect of MTL and "healthy choice" FOP labels on healthfulness of snack choices	Subjects: adults (n=160) Methods: choice experiment in laboratory setting	Healthier choices were promoted by simultaneously present MTL and "healthier choice" FOP labels, but not by either of the labels on their own.
Goodman et al. [48], 2013; Canada	Effect of FOP label on choice of products with high vs low sodium content	Subjects: adults (n=430) Methods: choice in experimental conditions	Higher selection of low-sodium among participants presented with descriptive FOP label, simple TL and descriptive TL label.

Impact on Food Choices

At the same time, there is some evidence supporting positive effect of FOP labels on food choices. A German survey showed that TL FOP labels decreased participants' preference for high-fat and high-sugar products in a choice experiment, compared with non-colour coded calorie information [33]. "Red" (high levels) element of TL scheme for had higher impact on decision making than "green" (low levels): i.e. participants had a very strong preference toward the products with "amber" sugar content, compared to "red" sugar content, whereas the difference in preference for "green" compared to "amber" sugar content was not as high.

Similar graduated effect on choices across levels of "healthiness" of the label was observed for the US Guiding Stars shelf labelling intervention [50••]. The study compared sales of ready-to-eat cereals in Hannaford stores after the implementation of Guiding Stars programme, with the sales in control stores over the same period of time. The study reports the highest increase in sale for products rated with 1 star (products with "good nutritional value" [42], 1.15 % increase), followed by 2 stars-products ("better nutritional value" [42], 0.89 % increase), with the lowest increase in the healthiest category of 3 star-rated products ("the best nutritional value" [42], 0.54 % increase). Another analysis of the Guiding Stars intervention assessed the effect on all product sales across all supermarkets pre- and post-intervention [51]. The analyses found that implementation of labelling reduced sales of less healthy products (no star rating), while there was no significant difference in overall sale of healthier products (1 to 3 star rating). As the result of this, the total sales across the supermarkets decreased after implementation of Guiding Stars labelling.

An online supermarket study in Australia is another study that evaluated the effect of FOP labelling on real-world food purchases over 10 week period [52]. MTL labels were applied to 53 retailer's own-brand products from five food categories. Analyses of sales data of the intervention and control stores did not indicate that MTL had an effect on food purchases. However, the range of products explored in a study was limited.

One study conducted in Germany and Poland argues that positive impact of FOP labels may only be applicable to the individuals who are already motivated to shop healthy [49]. A choice experiment on snack foods followed by an interview showed that FOP nutrition labels did not influence participant's intention to buy healthier food, and were only effective for those who were initially motivated to make healthy choices, or when they were specifically asked to choose healthier foods.

Adoption and Compliance with Guidelines

Several studies explored compliance of FOP labels with guidelines and reliability of labels in reflecting nutrition composition of foods. An independent audit on FOP daily intake guide (DIG) labels conducted in 2012 in Australia [39•] explored prevalence and format of DIG labels on high-energy snacks with low nutritional value. The study found 66 % of assessed products carried the DIG label. However, it also reports that only 51 % of manufacturers used DIG on all of their products, and approximately a third of them varied the format or presence of DIG depending on food type and category. Products exceeding healthy guidelines for certain nutrients would tend to either not have DIG, or have a selected version of DIG. "Energy only" DIG was the most popular version of DIG for most unhealthy products, although in most cases it was not consistent with the industry guidelines on DIG labelling [39•]. This particular finding is consistent with an earlier audit, also reporting "energy only" DIG to be the most prevalent across all food categories [40]. However, according to a recent study Australian shoppers have difficulties with understanding "energy" term on nutrition labels, often perceiving this as a positive quality of food [35]. Therefore "energy only" labels have a potential to be interpreted the incorrectly. Another US study supports this conclusion and claims that ability of industry to choose which nutrients to list can be confusing and misleading, and alter consumers' perception of food healthiness [41].

Selective application of FOP labels on foods with unfavourable nutrient content is also indicated by a study on FOP labelling in UK [53]. A total of 12 food categories were explored in a period of time that coincided with voluntary TL scheme implementation proposed by the Food Standard Agency (FSA) [43]. Among those categories, six were targeted by the voluntary FOP TL labelling scheme. The study found that five out of six target groups (meat products, pastry dishes, pizzas, prepared meals and sandwiches) were more likely to receive FOP labelling compared to other categories. Within categories, the most important predictor of FOP label use was brand, with a higher proportion of FOP labels in private brand. Use of FOP TL label was less in products with high salt, sugar, fat or energy content in some categories (meat products, pastry dishes, pizza and prepared meals). Use of FOP GDA labels was less in pastry dishes with high salt content, and in prepared meals with high sugar content, but was not associated with nutrient content in other categories.

Different Formats: Comparison of Effectiveness

The simultaneous presence of different FOP labels formats is reported to be confusing for consumers, preventing them from being able to directly compare products with different types of labels [44]. Many studies have attempted to identify the most effective labelling format that would get adequate consumers' attention, and would be easy to understand and reliable. A

previous systematic review comparing different formats of FOP labels [3, 45] found nutrient-specific labels to be better in helping to identify healthier products, compared to summary schemes, and colour-coded schemes to be better compared to text references.

Studies on different labelling formats published between 2011 and 2014 that were included in this review are summarised in Table 2. Among those studies surveys and survey-based choice experiments [46–48, 55–59], choice experiments in laboratory or other experimental setting [60, 61] and eye-tracking experiments [46, 47] were used to collect the data.

Comparison of Claims and Nutrition Labels

Participants' preference for labelling format appears to depend on both design and participant characteristics. A French study on perception and preference that compared simple and multiple traffic lights and three types of logos showed MTL to be the most preferred format of FOP labels [57]. However, preference for simpler formats (simple TL, logos) was associated with lower income and lower education level [57].

Several studies evaluated impact of claims and nutrition labels on consumers' ability to correctly identifying a healthier food item. Overall the results suggest nutrition labels are more effective than claims [46, 56, 58]. A comparison of choice logo with monochrome and colour-coded GDA labels in a choice experiment combined with eye tracking showed that colour-coded GDA had higher consumers' attention, which resulted in more frequent choice of the label-carrying product [46]. This was followed by monochrome GDA, with the choices logo receiving the least amount of attention [46]. A US survey comparing Choices with several FOP label showed that while the labels were similar in helping participants to identify a healthier choice, the MTL label was significantly more effective when participants' understanding of nutrient content was assessed [58]. A New Zealand survey compared sodium content claims with FOP nutrition labels showed that consumers were able to better identify low-sodium products when both MTL and a claim were present [56]. Presence of a MTL label also helped participants to avoid the confusion caused by misleading effect of "low sodium" claims on high sodium products [56]. Another study explored the effect of MTL and "healthy choice" logo labels on healthy choices in experimental conditions showed that presence of both labels simultaneously, but not either of them separately, promoted healthier snack choice among participants who were not specifically asked to choose healthy products [60].

Comparison of FOP Nutrition Labelling Format

Among different FOP nutrition label formats, colour-coded formats appear to be better understood, compared to monochrome labels. Thus a survey choice experiment conducted in Spain showed greater impact of colour-coded GDA on healthy food choices among adolescents, compared to the plain GDA system [55]. Participants exposed to colour-coded schemes chose significantly less energy, fat, sugar and salt [55].

Several studies identify TL as the most effective form of FOP nutrition labelling [47, 48, 56], whereas some report other interpretive formats to be equally effective [61, 62]. A study conducted in Germany and Netherlands combining online survey, computer choice experiment and eye tracking compared ability of several FOP nutrition labels to provide a reference point for a healthy choice, and thus enable consumers to choose relatively better products within one category, better category of products across food categories, as well as assessing not relative healthiness of a product on its own [47]. The study found that all label types were effective in communicating health messages in certain experimental conditions, however only MTL remained effective across all conditions. MTL, nutrition information panel (NIP) and GDA performed equally when comparing healthiness of products within one food category. When assessing the ability to choose the healthiest food category, the presence of MTL labels had significantly better results than NIP and GDA. Finally, MLT, but not other types of label, helped participants to successfully identify healthy products on their own, when no other choices were presented. Another survey showed MTL to be more effective compared to percentage daily intake and NIP labels in helping participants to correctly identify low-sodium products [56].

A recent New Zealand survey and choice experiment study comparing MTL, DIG and the new Health Star Rating (HSR) FOP system, recently introduced in Australia, showed that participants choose and identify healthy option more often when it carried MTL, closely followed by HSR, compared to no FOP [48]. MTL was the most effective FOP format in enabling participants to determine healthiness of isolated foods with three different nutrient profiling scores (good, moderate and poor). DIG and NIP were less effective, and the lowest result was observed for HSR. However foods with moderate and poor nutrient profiling scores were assigned the same HSR score in this experiment, which explains inability of participants to differentiate between them. The algorithm used for this label is different from the algorithm proposed for Australian HSR labelling [63]. Another choice experiment study conducted in Canada showed that participants presented with descriptive label and TL (descriptive and simple) selected significantly higher amounts of low-sodium products compared to control [61]. There was no difference between the descriptive label, descriptive TL and simple TL [61].

It is worth noting that the above studies used the MTL format initially proposed in 2007 [43], which was updated to a more complex format in the most recent style guide [62].

Current MTL may present nutrition information per portion, as opposed to per 100 g, and includes additional numerical reference information, similarly to DIG labels [62]. Those changes have the potential to affect interpretability of the label. According to a large European phone interview study, "per portion" presentation is consistent with consumers' preference [32]. However, the study also showed that more people were able to correctly interpret information presented "per 100 g", compared to "per portion" (40.8 % vs 33.6 %, respectively) [32]. In addition, a recent Australian survey suggested that simpler MTL formats may be more effective than formats featuring additional reference information [59]. The study compared the ability of several FOP nutrition labels to help participants identifying healthy choice. Although MTL was among the best performing formats, the study found it to be equally effective compared with DIG label, which is inconsistent with previous research reporting DIG to be less effective [3]. When discussing this finding, the authors suggest that it might be due to additional numerical references on the MTL label, which could have affected how easy the label was to interpret [59]. The study did, however, show that MTL label allowed participants to identifying healthier option more quickly than other labels [59].

Overall, nutrition labels appear to be more effective than claims. Among the nutrition labels colour-coded formats (multiple and simple TL, colour-coded DIG) appear to be better understood and to have greater impact on food choices than formats using text reference.

Conclusions

Despite a growing body of research on POP nutrition information, real world impact of such information on consumer food choices remains contentious. There is growing evidence supporting the ability of POP information, particularly FOP nutrition labels, to enable consumers to better determine the healthiness of food products [33, 50••, 56, 58]. One of the biggest limitations, however, is the small number of studies with objectively measured outcome data from retail interventions, with the majority relying on self-reported data or data obtained from experimental settings. There has been limited research undertaken in real world retail settings [30, 31, 50••, 51, 52]. In addition, such studies have some common limitations; including restriction to a small number of product categories [30, 50••, 52], limitation to one particular supermarket chain, and either lack of a control group or use of an external control group (i.e. different supermarket chains, different study period), which may have influenced the results. Another important gap in the evidence is that the effect of different FOP nutrition labelling schemes has not been compared in real world retail settings. Two large randomised controlled trials currently getting underway in Australia (B. Neal et al.; personal communication) and New Zealand (C. Ni Mhurchu et al.; registration number ACTRN12614000644662) aim to address this question by comparing the real-world effectiveness of different FOP labels, using a smartphone application to deliver the randomly allocated labels to consumers. These two trials aim to provide robust evidence on the impact of different FOP labels on real-world food purchases, and will generate important information on which to base food labelling policies.

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Compliance with Ethics Guidelines

Conflict of Interest Ekaterina Volkova and Cliona Ni Mhurchu declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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